OCO-2 Data Quality Statement: Level 2 Lite File Data Release 9 (V9) – October 10, 2018

The Orbiting Carbon Observatory (OCO-2) has released the latest version of the Level 2 (L2) data product, containing estimates of the column averaged dry air mole fraction (X_{CO2}), other geophysical quantities retrieved from OCO-2 observations. This version of the L2 Product is release 9.0 (V9) and has been processed based on version 8.0 (V8) of the OCO-2 Level 1 and Level 2 algorithms, but with a new processing that updated the ABP, IDP, Met and X_{CO2} Lite products.

The V9 data was created because the V8 OCO-2 data exhibited biases in X_{CO2} in areas of varied topography (initially shown in Wunch et al (2017) for V8). This variability in X_{CO2} was most obviously seen in target observations where the CO_2 values would clearly track the changes in the elevation of the measurement location (such as Lauder, New Zealand). Other cases were shown in the Wunch et al (2017) paper and additional examples were observed in the V8 nadir and glint data. The OCO-2 L2 team identified problems with the surface pressure estimates that in turn lead to biases in the retrieved (and bias corrected) X_{CO2} value. These problems in the surface pressure retrievals were in turn found to be related to how the pointing for each OCO-2 detector was determined. A fix to the pointing issue was determined allowing for improved X_{CO2} retrievals. A second error affecting the surface pressure retrieval involved how the surface pressure *a priori* value was determined from the meteorological model results. The OCO-2 retrieval software uses model results from the GEOS-5 Forward Processing for Instrument Teams (GEOS5-FP-IT) created at Goddard Space Flight Center Global Modeling and Assimilation Office (GSFC GMAO). It was found that when sampling the GEOS5-FP-IT surface pressure results, a bug caused the time interpolation between to be performed incorrectly.

Significant improvement in how the OCO-2 X_{CO2} data varies with altitude was shown when using improved geolocation for the eight OCO-2 footprints and fixing the meteorological data *a priori* sampling issue. The improvement is shown in Figure 1 for nadir and glint data over Death Valley. The left panel shows the variation in delta X_{CO2} for V8 pointing and then the values for the updated pointing (V9). Kiel et al. (2018) is a manuscript in preparation that will detail the development of the improved OCO-2 geolocation and how it improved the XCO2 data product. Information will also be included in the OCO-2 L2 Data User's Guide.

The fundamental means for tying the OCO-2 X_{CO2} to the World Meteorological Organization's CO2 standard is by comparison with ground-based observations from the Total Carbon Column Observation Network (TCCON). As with previous versions of the OCO-2 data products, the V9 data has undergone this validation analysis. The OCO-2 measurements in all observation modes: nadir, glint and target are compared to TCCON to evaluate potential biases in the satellite data (see Wunch et al., 2017 and Wunch et al., 2011). In addition to the comparisons to TCCON, the OCO-2 V9 data has

been compared to other estimates of X_{CO2} including global models and the previous version of OCO-2 data. Several different types of analysis have allowed for an estimate of the bias and scatter of the data. Figure 2 below shows comparison of the L2 data from OCO-2 target observations compared to TCCON, including the slope and correlation coefficient (slope of 0.99528±0.00134, r^2 of 0.942). The comparisons for glint and nadir mode data to TCCON tend to show similar correlations.

The OCO-2 L2 Algorithm team provides information on data screening, which utilizes different parameters within the L2 data product. A bias correction formula has been determined that allows for adjusting the OCO-2 data consistent with biases seen relative to independent estimations of X_{CO2}. Unlike past OCO-2 versions of the L2 data, there will not be warn levels that can be used for data screening. The expectation is that warn levels will be brought back in the next major release.

V9 of the OCO-2 L2 data will only be available through the "Lite" file data products. These Lite data products are grouped into daily files and provide a bias corrected X_{CO2}, in addition to the standard X_{CO2} values. The V9 Lite files will be available at the Goddard Earth Sciences Data and Information Services Center (GES DISC) OCO-2 site starting in October 2018.

There is much more documentation that will help with utilizing the OCO-2 L2 data, all of which are available at the GES DISC OCO-2 documentation page. Specifically, the Data User's Guide (DUG) provides an overview of the mission, and information about the key data fields in both the V9 L2 Lite files and the V8 standard products. The Data User Guide for V9 also provides guidance on data filtering and bias correction. The physics of the measurements and the retrieval technique are described in the L2 Algorithm Theoretical Basis Document (ATBD). Similarly, there is an ATBD for the L1b data. Some of these documents are in process of being updated after the release of the V9 data, but the majority of the content remains valid and relevant.

C. O'Dell et al., Retrievals of Carbon Dioxide from the Orbiting Carbon Observatory-2 with the ACOS algorithm, Atmos. Meas. Tech., submitted, 2018.

D. Wunch et al., A method for evaluating bias in global measurements of CO2 to-tal columns from space, Atmos. Chem. Phys., 11, 12317–12337, 2011 https://doi.org/10.5194/acp-11-12317-2011.

D. Wunch et al., Comparisons of the Orbiting Carbon Observatory-2 (OCO-2) XCO2 measurements with TCCON, Atmos. Meas. Tech., 10, 2209–2238, 2017 https://doi.org/10.5194/amt-10-2209-2017.

M. Kiel et al., How bias correction goes wrong: Measurement of XCO2 affected erroneous surface pressure estimates., submitted, 2018.

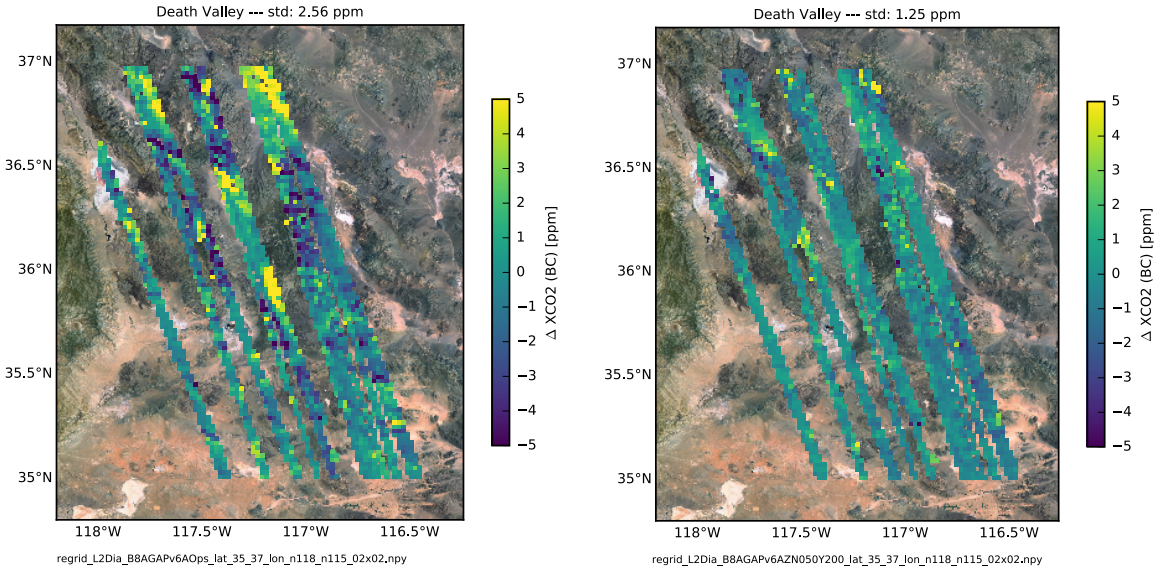

Figure 1. OCO-2 delta X_{CO2} results for Death Valley (left: variation of X_{CO2} over the Death Valley area using the V8 operational pointing – the variations in X_{CO2} follow the underlying change in topography, right: same for estimated new instrument pointing.

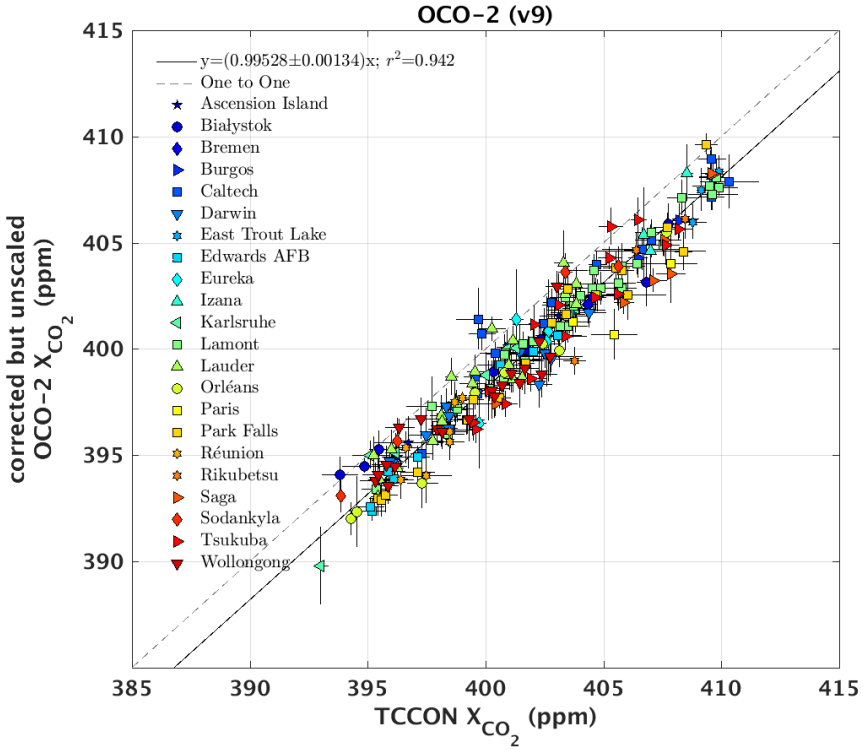

Figure 2. OCO-2 target observations compared to TCCON for V9. This is bias corrected V9 data without any scaling.